# Title: Random Walk

# Team:

## **OBjective**

Using the lab instructions generate a random walk, gather data and determine if it is possible to predict the outcome of random walks.

## **Safety discussion**

Since the team will be walking around the room randomly, take a look around the room and discuss any potential concerns such as trip hazards and the proximity of other teams or obstacles. Discuss what actions the team can take to minimize the chance of interacting with any of the identified obstacles.

## **Human PErformance Tools**

* **HOLD POINT** – designates that the group cannot proceed past this step without specific instructions from the Instructor(s).
* **Place Keeping** – When starting an instruction step circle the number, when the step has been completed put a slash through the circle.

## **EQUIPMENT**

* Coin
* Post-its
* Pen
* Paper
* Tape Measure
* Calculator (square root capable)

## **INSTRUCTIONS**

1. **HOLD POINT** – Instructor will lead a short discussion on Random Walk Theory.

*A****random walk****refers to any process in which there is no observable pattern or trend; that is, where the movements of an object, or the values taken by a certain variable, are completely random. Certain real-life scenarios that could be modeled as random walks could be:*

*• The movements of an animal foraging for food in the wilderness  
• The path traced by a molecule as it moves through a liquid or a gas (diffusion)  
• The price of a stock as it moves up and down*

1. Assign team members as indicated below:

* Data Taker
* Walker
* Measurement Taker
* Map Tracker

1. Place a post-it on the floor as the starting point, label as SP.
2. NOTE: Any step taken in the forward direction is considered as a positive (+) number and any step taken in the backwards direction is considered as a negative (-) number.
3. Select one team member to be Coin Flipper 1 (CF1) and have them stand on the SP and perform the following (Use Data Sheet 1):
   1. Flip the coin, if it comes up heads then take a step forward, if it comes up tails take a step backwards.
   2. Repeat this process until 5 coin flips are completed.
   3. Place a post-it at the end point for CF1 and label it CF1.
   4. Measure the distance from the SP to CF1.
4. Select one team member to be Coin Flipper 2 (CF2) and have them stand on the end point CF1 and perform the following:
   1. Flip the coin, if it comes up heads then take a step forward, if it comes up tails take a step backwards.
   2. Repeat this process until 5 coin flips are completed.
   3. Place a post-it at the end point for CF2 and label it CF2.
5. Measure the distance from the SP to CF2.
6. Select one team member to be Coin Flipper 3 (CF3) and have them stand on the end point CF2 and perform the following:
   1. Flip the coin, if it comes up heads then take a step forward, if it comes up tails take a step backwards.
   2. Repeat this process until 5 coin flips are completed.
   3. Place a post-it at the end point for CF3 and label it CF3.
7. Measure the distance from the SP to CF3.
8. Examine the data gathered for CF1, CF2 and CF3, answer the following questions:
   1. What is the pattern that is emerging associated with each sequence of steps?

*Pattern should be something along the lines that the distance from the SP is increasing by one step for each sequence of steps.*

* 1. Formulate a hypothesis based on the examination of the data. If possible develop a mathematical model.

*Hypothesis Sample: For each sequence of steps by a CF the distance from the SP should increase by 1 step. Distance = (1 step) X (# Sequences).*

* 1. Make prediction on the end point for the last Coin Flipper.

*The end point for the last Coin Flipper should be equal to the number of Coin Flippers.*

1. Have the remaining Coin Flippers stand on the previous end points and perform the following:
   1. Flip the coin, if it comes up heads then take a step forward, if it comes up tails take a step backwards.
   2. Repeat this process until 5 coin flips are completed.
   3. Place a post-it at the end point for the Coin Flipper and label it with the Coin Flippers’ number. When the last CF has complete their steps measure the distance from the SP to the final CF, this will be the end point (EP).
2. Examine the data gathered for all Coin Flippers and answer the following questions:
   1. Was your prediction on the position of the last Coin Flipper close to the Average Distance (Davg)? YES NO

*This answer should be YES, close is subjective but this distances should not vary by more than 2 – 4 inches.*

* 1. Was your prediction on the position of the last Coin Flipper close to the square root of the Total Number of Steps (N)? YES NO

*This answer should be YES, close is subjective but this distances should not vary by more than 2 – 4 inches.*

* 1. Discuss with your team the relationship between Davg and the square root of N.

*It is doubtful that many teams will make the relationship connection of root mean square, other alternatives should be encouraged and discussed that seem to be a reasonable approach to the problem. The root mean square will be discussed below.*

1. **HOLD POINT** – Instructor will lead a short discussion on the results and conclusions by the teams.

*For the example of a linear random walk the math works out to Davg = Square Root of N. This relationship represents a Root Mean Square meaning it is the square root of the average of the squares of a set of values regardless of their sign. Though not highly accurate it does provide a simple method for predicting the outcomes of random motion. This relationship should hold true for 2-D and 3-D random walks, but could be too inaccurate for some types of experiments. We should focus on developing a unique method for predicting position for our 2-D model and check it against the mathematical model of D = square root N.*

1. For the second part of the experiment we are going to incorporate a 2-D random walk, the only rule is that a coin flip of heads is a step to the right and a coin flip of tails is a step to the left.
2. Work with your team to determine what data will be gathered, how many Coin Flippers to use, and how many coin flips to use to develop a hypothesis or mathematical model to make a prediction for the final position of the last coin flipper.
3. Conduct your experiment and capture the data on Data Sheet 2.

**DATA SHEET 1**

|  |  |  |
| --- | --- | --- |
| CF | Number of Steps (n) | Distance Travelled (d) |
| 1 |  | d1 \_\_\_\_\_\_\_\_\_ in. |
| 2 |  | d2 \_\_\_\_\_\_\_\_\_ in. |
| 3 |  | d3 \_\_\_\_\_\_\_\_\_ in. |
| 4 |  | d4 \_\_\_\_\_\_\_\_\_ in. |
| 5 |  | d5 \_\_\_\_\_\_\_\_\_ in. |
| 6 |  | d6 \_\_\_\_\_\_\_\_\_ in. |
|  | Total # Steps  (N) | Total Distance  (D) |
|  |  |  |
|  | Square Root N | Average Distance (Davg) |
|  |  |  |

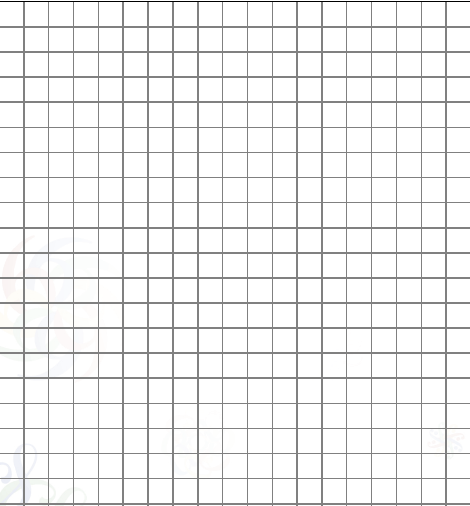
**DATA SHEET 2**

*The goal here is to allow the exploration of a 2-D Random Walk, determining which data may be useful and invent a method to make predictions. It is not required that this be highly accurate but be a reasonable method based on factual data and sound mathematics.*

Questions:

1. Hypothesis for Second Experiment:
2. Conclusions or findings from experiment that supports or does not support the hypothesis:

**MAP 1**



**MAP 2**

